The composition of a planet's atmosphere affects the climate on the planet's surface. A thick layer of carbon dioxide, for instance, drives the temperature on Venus to a whopping 467°C. On Earth, in contrast, the atmosphere is dominated by nitrogen, but there is enough carbon dioxide and other greenhouse gases to keep the surface warm enough for life. In the past, though, Earth's atmosphere has been very different, with levels of oxygen and carbon dioxide fluctuating over time.

Kasting has made fundamental insights into this atmospheric evolution through the development of numerical models. The core of his research has been the greenhouse gas carbon dioxide. He has calculated the minimum levels of carbon dioxide needed to prevent the planet from freezing into a "Snowball Earth" scenario, for instance. And he and his colleagues have used his models to determine when the planet's carbon dioxide will run out and its water will be lost, calculating that the Earth will no longer be able to support life in another 2 billion years or less. Kasting's studies into the evolution of carbon dioxide and other atmospheric gases—such as oxygen, methane, and nitrous oxide—have provided insight into the proliferation of life on the early Earth. He has also made major contributions in the search for life on other planets, including refining the concept of the "habitable zone"—the region around a star where a planet can support liquid water and possibly life.